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GUAM AGRICULTURAL EXPERIMENT STATION,
J. B. THOMPSON, Special Agent in Charge.

ANNUAL REPORT OF
THE GUAM
AGRICULTURAL EXPERIMENT STATION
FOR 1911.

UNDER THE SUPERVISION OF
OFFICE OF EXPERIMENT STATIONS,
U. S. DEPARTMENT OF AGRICULTURE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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GUAM AGRICULTURAL EXPERIMENT STATION, ISLAND OF GUAM.

[Under the supervision of A. C. TRUE, Director of the Office of Experiment Stations, United States Department of Agriculture.]

WALTER H. EVANS, *Chief of Division of Insular Stations, Office of Experiment Stations.*

STATION STAFF.

JOHN B. THOMPSON, *Special Agent in Charge.*

PETER NELSON, *Assistant.*

LETTER OF TRANSMITTAL.

GUAM AGRICULTURAL EXPERIMENT STATION,
Island of Guam, February 27, 1912.

SIR: I have the honor to transmit herewith the Annual Report of the Guam Agricultural Experiment Station for the fiscal year ended June 30, 1911.

Respectfully,

J. B. THOMPSON,
Special Agent in Charge.

Dr. A. C. TRUE,
*Director Office of Experiment Stations,
U. S. Department of Agriculture, Washington, D. C.*

Publication recommended.

A. C. TRUE, *Director.*

Publication authorized.

JAMES WILSON, *Secretary of Agriculture.*

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ANNUAL REPORT OF THE GUAM AGRICULTURAL EXPERIMENT STATION FOR 1911.

SUMMARY OF INVESTIGATIONS.

By J. B. THOMPSON, *Special Agent in Charge.*

INTRODUCTION.

From an agricultural viewpoint the past year has been one of comparative prosperity in Guam. The output of coconuts was much greater than that for the year 1910. The customhouse returns show an increase in copra exports of 64 per cent over those of the preceding year. This increase comes in great part from young plantations which are just coming into bearing. Prices of copra have remained uniform throughout the year, with a slight advance over those paid in 1910. Japanese traders, who own or control their own line of sailing schooners plying between Yokohama and the islands of the Mariana group, continue to control the copra market; and they have handled the bulk of the year's output of copra. A small consignment was shipped to Manila by H. V. Costenoble, a local merchant, with the hope of opening a more favorable market.

One of the most keenly felt wants of the producers here is transportation facilities that can be relied upon to carry the island products regularly and directly to a good market. The United States Army transports call at Guam once per month on their outward run from San Francisco to Manila, but these vessels do not touch here on their return trip. The present transport regulations admit of a limited amount of provisions and other necessities being carried from San Francisco and Honolulu to Guam, but the shipment of copra from Guam to Manila is not allowed. In the absence of other shipping means, provision by which the island's products could be shipped to Manila by United States Army transports would place them upon a market where keen competition would insure better prices, and better prices could not fail to encourage the development of the copra and other agricultural industries. The monthly cargo of supplies discharged at Guam by the transports during the past year have ranged from about 150 to about 450 tons, and the space thus made vacant between Guam and Manila would be sufficient to carry, at a very conservative estimate, three times the amount of copra now exported from the island.

PERSONNEL.

Mr. P. Nelson was appointed agent, effective May 1, 1911, his duties being that of a general assistant to the special agent. The station is fortunate in securing in Mr. Nelson a man who is well qualified to perform work on various lines. Much of his time has been occupied in clerical work and in supervising the construction of buildings and the installation of the water system and other machinery.

By direction of the Secretary of Agriculture, Mr. David T. Fullaway, entomologist of the Hawaii Agricultural Experiment Station was detailed late in the year for duty at this station. Between the date of his arrival (May 27) and the close of the fiscal year he was employed in making general investigations of an entomological nature, including the collection for identification of the insects of the island. This work when completed will be of special interest and value, constituting, as it will, the most thorough account of the insects in the Guam fauna. A partial report of his investigations is appended.

IMPROVEMENTS.

The new office building which at the end of the last fiscal year was in course of construction and was mentioned in the last annual report has been completed and occupied since October 1, 1910, when rental on the quarters previously occupied was discontinued. (Pl. I, fig. 1.)

A storehouse for the shelter of farm tools was completed early in the year and since then has supplied a much needed improvement. Here in a tropical climate where wet periods covering several months regularly obtain, and with an ever-high atmospheric humidity, deterioration of agricultural implements rapidly results. A constant salt-laden sea breeze also plays an important part in accelerating the usual process of oxidation of steel and iron tools. These conditions existing in Guam tend to make necessary complete shelter for all farm tools and machinery. The building erected during the year includes, in addition to a large closed shed for housing the more bulky equipment, a power room and workshop, in which the pump and kerosene engine are installed.

A frame barn was erected during the months of April and May to provide shelter for the live stock which at that time was expected to arrive from the United States in June. The building is 30 by 40 feet in dimensions, with stall room for 12 head of stock, a feed and harness room, and a large storage floor for hay and grain above. The material used in the structure is largely Oregon pine and California redwood, with Japanese corrugated zinc for roofing. In its construction, convenience, utility, economy, comfort to animals, and neatness of appearance have all been considered; and it is believed that considering the material and labor involved, the final cost, which will not exceed \$800, is unusually low. (Pl. I, fig. 2.)



FIG. 1.—OFFICE BUILDING.

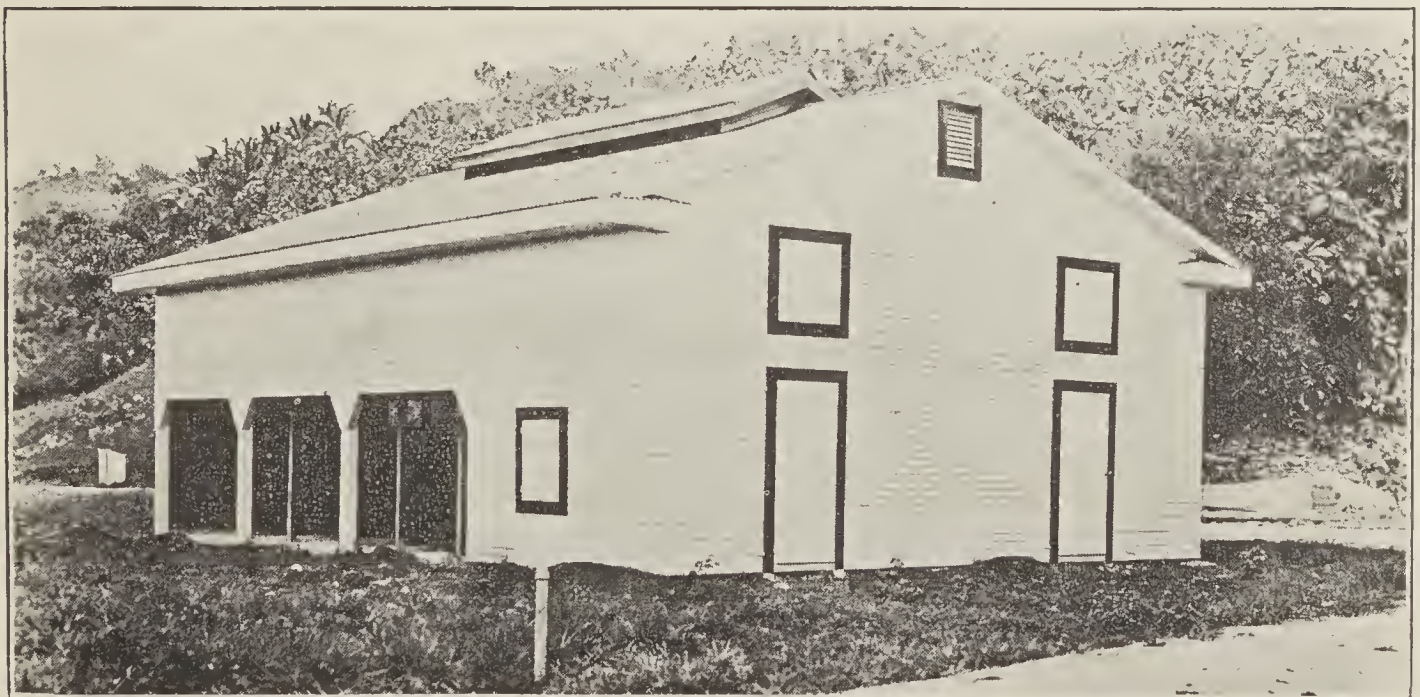


FIG. 2.—NEW STOCK AND IMPLEMENT BARN.

The road system of the station has been extended by the construction of about 1,000 feet, leaving about an equal amount of the system as originally planned to be constructed as time and funds are available. Walks have been laid about the new office building and a lawn covering an area of about 1 acre has been made. This improvement, while comparatively inexpensive, has added much to the appearance of the station, lending to the surroundings an air in keeping with that of the new building and evoking much favorable comment. Bermuda grass, *Capriola dactylon*, one of the most common grasses of the island, has been utilized for sodding. Economic and ornamental trees and shrubs have been planted, and hedges growing about the grounds have been kept neatly trimmed in order to set before the people an example of neatness and cleanliness which is so generally lacking about the native home.

OFFICE WORK.

The completion of our new office building placed the work on a more substantial basis, and modified methods of keeping records and handling correspondence made necessary by the lack of suitable office facilities have been elaborated and improved upon, resulting in greater satisfaction in the work and in greatly increasing the usefulness of all records and reference files. A marked increase in the amount of necessary office work has developed during the past year, due to an increase in all lines of field operations and to a much wider range of correspondence than had previously been maintained. The new building furnishes accommodations for furniture and laboratory equipment, and much of these office supplies have been provided during the year. A large number of bulletins and other publications and a reasonable number of volumes on agricultural and allied subjects have been collected, forming a nucleus of what it is hoped to make a good working library. The appointment on May 1, 1911, of Mr. P. Nelson, mentioned elsewhere in this report, insures greater permanency in the system of records, since it is through his knowledge of record and account keeping that the system has been developed.

FIELD OPERATIONS.

Both field and garden crops have generally given better success during the past year than during any previous period in the history of the station. This is largely due to improved soil conditions which follow continued cultivation of a soil long uncultivated and packed through the trampling of animals and heavy tropical rains. Light applications of stable manure upon certain portions of the station grounds, where the lack of fertility was most noticeable, have resulted in a distinct improvement, as shown by greatly increased yields.

The past dry season was rather more definite and more prolonged than that of the foregoing year, but with water available for irrigation the lack of moisture was not seriously felt. Irrigation was employed to a very limited extent only, and upon properly tilled soil was found necessary only for forcing ratoon growth on newly cut areas and in the case of certain surface-feeding vegetables which require light waterings rather than thorough irrigation.

CORN.

On July 1, 1910, a field of corn, a portion of which was of the Large Mexican June variety obtained from the Bureau of Agriculture in Manila, and the remaining part of the common native variety, was in a growing condition, having been planted during the preceding year. Damages caused by cattle and carabao which gained entrance to the field, and from unusual heavy rains immediately preceding harvest, rendered an authentic yield comparison of the two varieties impossible; but the results of the test were clearly favorable to the introduced variety. The yield of the Large Mexican June corn was decidedly heavier than that of the native variety, while the ears of the former were larger and more perfectly filled, the cob smaller, and the grain deeper and less flinty than in case of the latter. Unexpected results following the storage of seed from this planting are interesting and point to a possible distinct difference in the power shown by acclimatized and nonacclimatized varieties to retain vitality. Selected ears of each of the varieties were shelled and dried on September 9 and 10; and on the latter date this seed was bottled and sealed under exactly similar conditions. The bottled seed was placed upon a shelf in a cool room and remained there for nine months. On June 10, 1911, the seals of all these bottles were broken and the seed from all, including two bottles of the Large Mexican June variety and five of the native variety, was planted in the same manner and under apparently similar conditions. The seed of the native corn germinated almost perfectly, while that of the introduced sort failed to produce a single stalk from $3\frac{1}{2}$ pounds of seed. The cause of this variation can not, however, be referred with absolute certainty to a varietial difference as a result of a single trial, as the difference might possibly be due to some other unobserved factor.

At the close of the period covered by this report $2\frac{1}{2}$ acres of corn, a portion of which is of specially selected seed, was growing on the station grounds, and at that time the crop was in good condition and gave greater promise of a good yield than any field in the vicinity of the station, though growing on soil which utterly failed to produce corn during the preceding year.

Communications have been addressed to more than 50 foreign agricultural experiment stations and American consuls in tropical sections with the object of obtaining a large number of varieties from climatically similar regions for trial at the station during the coming year. Corn is a staple food article in Guam, and an increase in its production will tend to lower the quantity of rice annually imported for food purposes. Rice land here is limited to a comparatively small acreage. Corn land, on the other hand, is found in areas sufficient to feed more than the island's population if properly handled.

PARA GRASS.

This grass, *Panicum molle*, was introduced near the close of the previous fiscal year, and during the past 12 months it has proved one of our best forage crops where the soiling system of feeding is practiced. The first introduction of this grass was made in May, 1910, when 25 root clumps were received from the Hawaii Agricultural Experiment Station. So rapid has been the propagation that several large wagon loads of roots have been distributed in addition to material required for planting a plat of 1 acre on the station grounds. At the close of the year the station had available plants sufficient to plant another plat of 2 acres, and this ground was in a state of preparation awaiting only the advent of favorable weather when the planting could be safely made. Para grass grows rapidly, sending out long runners in every direction, and these runners coming in contact with the soil send out roots at the nodes, forming new plants. Owing to this habit of growth, plants may be set from 5 to 10 feet or even at greater distances apart, and under favorable conditions a thick sward will be grown in a comparatively short time. When planted at wide intervals early growth is of low, trailing decumbent nature; but when the surface is once covered, an upright habit of growth is assumed rendering the crop easily cut and well adapted for soiling purposes. Many native owners of live stock have commented upon the success of this grass at the station, and a few have obtained and planted roots to supply feed for their own animals. A supply of Para grass is kept constantly available to meet, as nearly as possible, all demand arising for roots for planting. (Pl. II, fig. 1.)

PASPALUM DILATATUM.

A tract comprising a little more than 1 acre was planted to this grass early in the dry season, and it has fulfilled in complete measure the success indicated in previous work. It withstood the drought of the past season without irrigation and furnished a good supply of nutritious feed. Since this planting was made Para grass has de-

veloped so favorably that it is now believed this latter species will prove better suited to general conditions in Guam. *Paspalum dilatatum* has proved successful in every way, but it has simply been excelled by what is now found to be a more suitable species. (Pl. II, fig. 2.)

OTHER FORAGE CROPS.

Guinea grass, *Panicum maximum*, has been grown again during the past year and, due largely to improved soil conditions, much more satisfactory results have been obtained. Further improvement will undoubtedly increase the yield; and upon suitable soil, where a large number of stock is to be fed from a relatively small area of land, this will be found a valuable crop for soiling purposes. In Guam, Guinea grass requires a fertile, well-drained, friable soil, and it will not give best results where these conditions are not furnished. Land adapted to its growth here is limited to a comparatively small acreage, and hence it is not probable that it will ever figure prominently in its forage problems. (Pl. II, fig. 3.)

Work with the sorghums has been conducted upon a considerably reduced scale during the past annual period. Sufficient data have been collected from previous work to establish the value of fodder crops of this class and to indicate how far they may be depended upon to furnish a continuous supply of green feed for live stock. Extensive plantings have, accordingly, been discontinued until work on animal problems is started, when planting will be resumed to furnish a portion of the required feed. Results from small plantings during the year have simply confirmed conclusions indicated from previous plantings.

MISCELLANEOUS FIELD CROPS.

Among other successful field crops grown at the station the pigeon pea, *Cajanus indicus*; the jack bean, *Canavalia ensiformis*; and the common peanut are worthy of special note. The pigeon pea furnishes a good substitute for garden peas, which do not succeed well here, and the dried peas, if they can be economically produced, might supply a staple food. Scattered plants of the pigeon pea are seen occasionally, but the crop has never been introduced into general cultivation.

VEGETABLE GARDENING.

At the close of the wet season a garden plat was specially prepared by a liberal application of stable manure and by deep and thorough stirring of the soil. Garden beds of uniform size were laid out systematically in this prepared section and marked with permanent numbered label stakes. (Pl. III, fig. 1.) As was men-



FIG. 1.—PARA GRASS.



FIG. 2.—PASPALUM DILATATUM.



FIG. 3.—GUINEA GRASS.

FORAGE GRASSES SUCCESSFULLY INTRODUCED BY THE GUAM
STATION.



FIG. 1.—VEGETABLE PLATS.



FIG. 2.—WHITE CHINESE RADISHES, NO. 117.

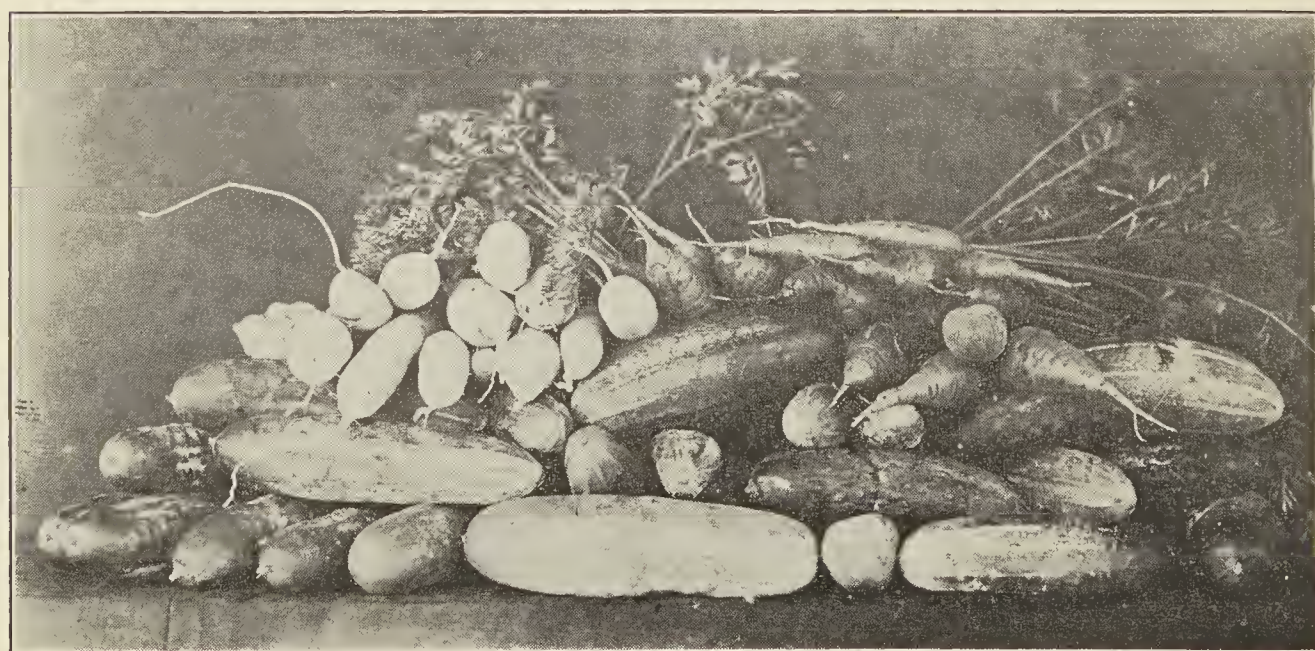


FIG. 3.—VEGETABLES GROWN BY GUAM STATION.

tioned in a preceding page of this report, greater success has attended this work during the past year than during any similar period in the short history of the station. Vegetables have almost without exception produced better yields and the product has generally shown an improvement in quality. These results were, however, to be expected, as the station soil was previously in very poor condition, and due allowance was given in case of numerous failures attributed to this cause.

In the last annual report of this station reference was made to a defoliating caterpillar which attacked and destroyed the leaves of garden beets, causing almost a complete failure of this vegetable. During the past year successive plantings were made with the hope of discovering some season for the development of the beet during which no brood of this lepidopterous larva is present. The work has not resulted in complete success, though a planting made on March 29 has been less seriously affected than any crop previously grown at the station. Many of the beets grown from this drilling had at the close of the fiscal year attained the dimensions of from $1\frac{1}{2}$ to 3 inches in diameter, and were suitable for table use, being as sweet and tender as could be desired. This crop is the only one that has not been entirely destroyed by the ravages of the caterpillar, and this one sustained considerable injury from the same insect. Beets have generally made rapid and vigorous growth while clean of pests, and it is believed that with these enemies controlled it would prove an entirely successful crop. The entomologist has reared the moth from this caterpillar and found it to be the beet webworm, *Hymenia fascialis*.¹

PATOLA.

This edible dishcloth gourd, *Luffa aegyptiaca*, has been introduced and grown at the station with the most satisfactory results during the past year. The species was more or less common during the Spanish régime; but it had become almost if not entirely extinct on the island. It is prized by the natives of Guam, and is cooked and served with meats, soups, and stews. The seed employed in our work was obtained from Manila, and the quantity received was sufficient to allow a limited amount for distribution.

ONIONS.

Much difficulty has been met in our attempts to grow onions from the seed, owing to the seeming impossibility of storing the seed and preserving its vitality in the humid atmosphere of Guam. A lot of seed obtained and planted under otherwise favorable conditions 13

¹ This species is discussed somewhat in detail by H. O. Marsh, with full consideration of remedies, in U. S. Dept. Agr., Bur. Ent. Bul. 109, pt. 1.

days after its arrival from California failed to grow. Six different varieties were represented in this lot, and the germination results ranged from less than 1 per cent to a total failure. The same difficulty has been experienced before in each attempt to grow onions, and in order to obtain a stand we have recently received and planted a quantity of onion sets. These were received in good condition near the close of the year and give fair promise of success.

RADISHES.

Work has been in progress to determine the possibility of growing radishes throughout the dry season. The results of these successive plantings have been very successful, practically no difference in yield or in quality of roots being shown from plantings made at various times from early in December to the latter part of March. A comparative test of seven different varieties showed a large, stump-rooted, white variety (No. 117) to have distinctly superior qualities over all others represented when grown under Guam conditions. This variety was grown from Chinese-produced seed, introduced from Manila by the station, and is quite distinct from Chinese White Winter, which is widely advertised by Pacific coast seed dealers, and which was one of the varieties grown in the experiment to which allusion has just been made. Top growth of No. 117 is unusually vigorous, and it has been observed that a caterpillar, which damaged other varieties by weaving webs in and feeding upon the leaves, did little or no damage to this one. This variety matures here two or three days later than some of the other varieties, but it develops more uniformly and remains crisp and tender for a longer period. As a means of comparing the results of radishes grown in Guam and the well-known yields obtained elsewhere, a note from our past year's records may be of interest. A garden bed containing an area of 400 square feet was planted to No. 117 on December 31, and the first radishes were pulled January 27, just four weeks after planting. The last of the crop, which amounted to 83 dozen good marketable radishes, was harvested on February 18, seven weeks from planting. The seed was sown in drills 15 inches apart, and a considerably greater yield would no doubt have resulted from closer planting. The radishes were large and uniform in size, crisp and tender in quality, and remained free from pith to the very last. (Pl. III, fig. 2.)

OTHER VEGETABLES.

Cucumbers have produced exceptionally heavy yields throughout the dry season, and the quality has been beyond criticism. The vines have at certain times been somewhat damaged from the attack of

aphidids but generally the plants make remarkably rapid and vigorous growth and consequently are not seriously injured unless the infestation is unusually grave. (Pl. III, fig. 3.)

Carrots have been grown at the station during the past year for the first time and results with them have been entirely satisfactory. (Pl. III, fig. 3.)

Lettuce, eggplants, peppers, and watermelons (Pl. IV, fig. 1) have all given favorable results from a viewpoint of production and quality. Muskmelons have yielded well and the melons have been large and well formed, but during the past year they have not ripened normally and in consequence have been lacking in flavor. Cabbage failed, due it is believed to too late planting. Tomatoes have given but little promise and while it is still believed that some success may be had during a short period in the coolest months of the dry season the cultivation of this vegetable is considered as very uncertain. There is a demand here for fresh tomatoes not only from the American residents, but also among the native inhabitants, and work will be continued with the hope of discovering new methods or new varieties which may make its production possible.

An indication of growing interest in garden work is the increased number of requests for seed for planting, and among these applications a desire is shown for varieties that apparently failed to attract interest during the preceding year. All requests for both garden and field seeds have been granted as far as seeds have been available, and instructions as to methods of planting have been given and every encouragement offered to promote interest and bring success to the planter.

ORCHARD NOTES.

PINEAPPLES.

The Smooth Cayenne pineapples introduced and planted during the fiscal year 1909 fruited for the first time during the current season. These fruits show a striking improvement in size over those of the variety commonly grown on the island and the flavor of the new sort has generally been pronounced the better. Single fruits of the Smooth Cayenne have weighed as much as 10 pounds while none of the common variety of half that weight have been brought to our attention (Pl. IV, fig. 3). The flavor of the introduced variety as grown at this station compares favorably with that of the same variety produced in Hawaii. Much interest has been manifested in the new fruit and numerous requests for plants have been received. All available plants have been distributed and in order to furnish more to responsible parties and to get the improved variety disseminated as soon as possible over the island, an order for 1,000 suckers has been placed with a Honolulu firm, and a further distri-

bution will be made upon the arrival of these plants. (Pl. IV, fig. 2.)

Plants of several other standard varieties have been obtained during the past year and with the multiplication of this stock the station will be in a position to furnish plants of several of the recognized superior varieties. These introduced varieties consist of Red Ceylon and Giant Kew, obtained from Ceylon; and Abachi, Porto Rico, Red Spanish, and Queen, from Florida. All these varieties have been planted on the station grounds and are making as good growth as could be expected.

CITRUS TREES.

The oranges, lemons, and pomelos introduced from California during the fiscal year 1910, and mentioned in the annual report of the station for that year, have made satisfactory growth. Disregarding the attack of scale and mealy bugs, which have done no serious damage, they have remained thrifty and vigorous throughout the year (Pl. V, fig. 2). Trees of the Satsuma variety of orange, *Citrus nobilis*, and of the kumquat, *C. japonica*, have been introduced from Japan and planted near the close of the past fiscal year.

JAPANESE PERSIMMONS.

Early in the year a small seedling persimmon was obtained from Manila, and, although it was received in a damaged and unpromising condition, it soon recovered and made rapid growth, assuming a healthy and vigorous state within a few months from planting. This encouragement has led to the introduction from Japan of grafted trees of 10 of the best varieties. Soil of a suitable type for planting these trees was not available on the station, but an effort has been made to improve conditions as far as possible, and it is hoped that the experiment may meet with some success. Sufficient trees were obtained to allow of the distribution of a limited number, and in following this course plantings have been made on a range of soil types, and the future development of these trees will be an index to the soils and situations best adapted to this fruit. The introduced varieties are: Daidai maru, Tsuro-no-ko, Kuro-kuma, Hyakume, Zenji, Nitari, Gosho-gaki, Twentieth Century, Hachiya, and Seedless.

PEACHES.

An introduction of peach trees consisting of varieties of the Peento type has been made in order to test the possibility of their success here. The soil at the station is entirely too heavy and retentive of moisture for the welfare of the peach, and it was found necessary



FIG. 1.—WATERMELONS.

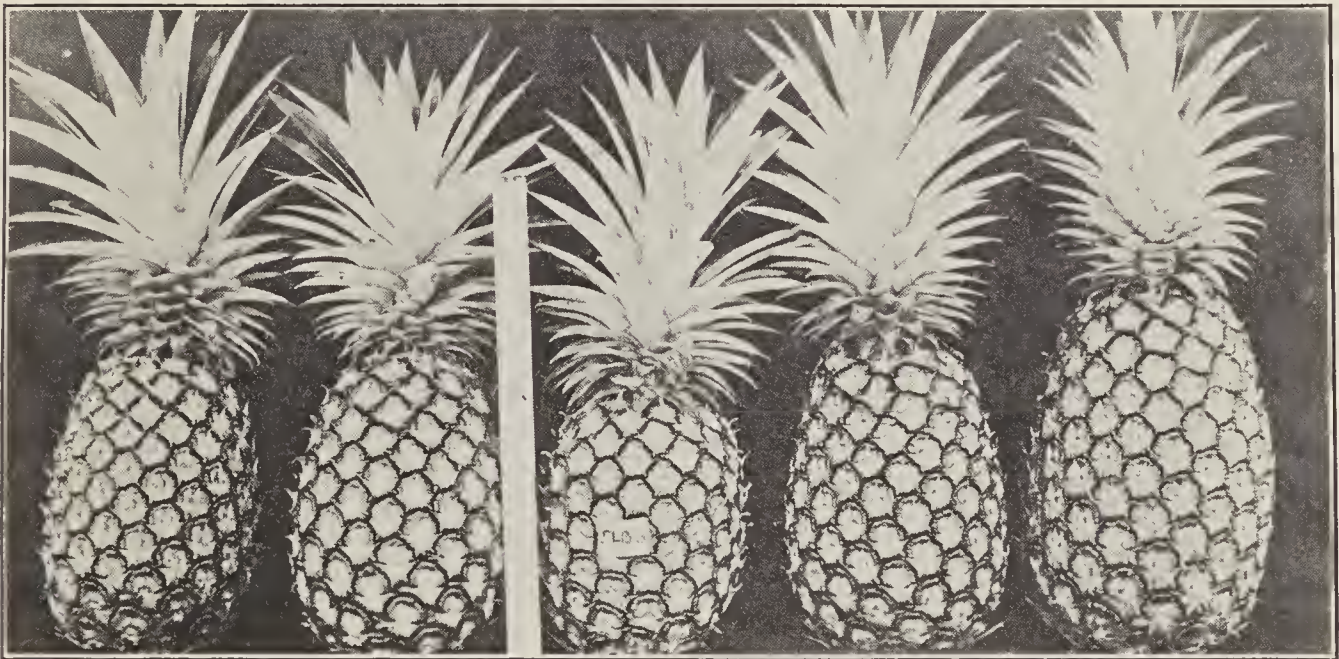


FIG. 2.—SMOOTH CAYENNE PINEAPPLES.

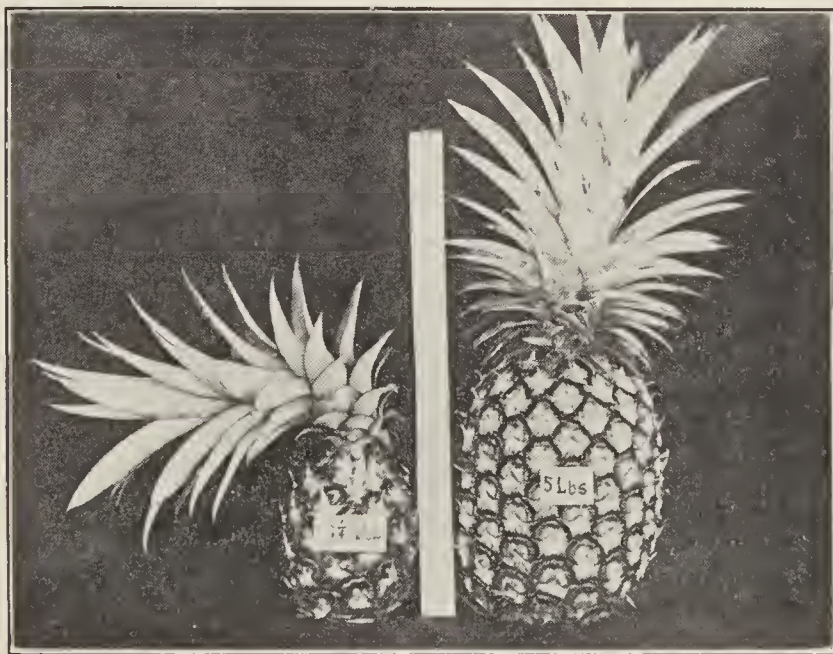


FIG. 3.—NATIVE VARIETY AND SMOOTH CAYENNE PINEAPPLES.

to make special preparation by digging holes in the "cascajo" hill, a formation of limestone gravel, and filling these with suitable soil. These holes were dug 6 feet square and from $4\frac{1}{2}$ to 5 feet in depth. This plan insures perfect drainage, which is an absolutely essential factor in a climate of more than 100 inches of rainfall per annum. The trees under discussion were planted late in March and have made a growth of 3 feet in as many months, and at the close of the year they seemed quite promising.

GRAPES.

A few vines of James, Meisch, and Scuppernong, all varieties of the southern or Muscadine grape, *Vitis rotundifolia*, have been introduced from Florida, and at the close of the fiscal year these vines are in a thrifty and growing condition.

STRAWBERRIES.

A perfect-flowered variety of the strawberry, which has given greatest promise among a number of varieties tested in Manila, was introduced during the past year, and at the close of the fiscal year covered by this report a comparatively large number of plants were available for planting. The original introduction consisted of only six plants, and one of these produced a few fruits during the year; but the object being the propagation of plants, fruiting was not encouraged. Seeds from these berries were planted and a number of thrifty young seedlings have been obtained. The resulting plants, all of which sprang from a single parent, the only flowering plant of the species on the island, are watched with considerable interest.

BANANAS.

The bananas introduced from Manila during the fiscal year 1910 have made good growth and have multiplied, making the distribution of a limited number of plants possible. A further introduction from Manila, this time of the Philippine varieties, Saba, *Musa paradisiaca compressa*, and Matavia, *M. paradisiaca maxima*, has recently been made.

OTHER FRUIT INTRODUCTIONS.

A comparatively large number of miscellaneous fruits, a majority of which are of purely tropical habits of growth, have been introduced during the year ended June 30, 1911. Included in this number are the following important acquisitions: The Kai-apple, *Aberia caffra*, and the allied species, *A. gardneri*; the Bignay of the Philippines, *Antidesma bunius*; the Jak fruit, *Artocarpus integrifolia*; the white Sapota of Mexico, *Casimiroa edulis*; the Sea-grape, *Coccoloba uvifera*; the Mabolo of the Philippines, *Diospyros discolor*,

and the related species, *D. ebenaster*, each of the latter two yielding in addition to an edible fruit a valuable ebony; the Rose apple, *Eugenia jambos*; the Philippine lanzones, *Lansium domesticum*; the Marmalade plum of the West Indies, *Lucuma mammosa*; the Japanese Nagi, *Myrica rubra*; the Longan, *Nephelium longanum*; and the Guinea guava, *Psidium guineense*.

MISCELLANEOUS PLANTS.

Among plants not mentioned elsewhere, a few others are sufficiently promising to merit report: Ceara rubber, *Manihot glazovii*, seedlings have made a remarkably good showing. Measurements of one of these seedlings taken exactly one year after the seed was planted showed a growth during that period of 16 feet in height and 10 inches in circumference at 3 feet above the ground. These trees are, however, very easily broken, and unless well protected are subject to serious damage by strong winds. Seeds of the kola nut, *Cola acuminata*, have been obtained from Ceylon, and the young seedlings grown from them are in good thrifty condition. A number of seedlings of the camphor tree, *Camphora officinalis*, have been introduced from Japan, and these have been sent out to planters for trial in various districts of the island.

Aside from plants of a strictly economic nature a few of purely ornamental interest have been introduced and are being propagated at the station. The ornamental hedge or bedding plant, *Barleria cristata*, which has been the object of much admiration and comment by Manila visitors, has been introduced in two varieties, and plants propagated from them by softwood cuttings have already become well distributed over the island. A single plant of *Bougainvillea spectabilis* has been successfully introduced. Two plants of the so-called Cape jasmine, *Gardenia jasminoides*, have been brought in, and a limited number of plants have been grown from this stock and distributed to the people.

Specimen plants of the African oil palm, *Elæis guineensis*; the wine palm, *Caryota urens*; and Para rubber, *Hevea brasiliensis*, have been introduced and are now growing on the station grounds. A few plants each of St. Lucia grass, *Capriola dactylon* var. and St. Augustine grass, *Stenotaphrum secundatum*, were received from Florida near the close of the year.

FRUIT GROWING IN GUAM.

One of the most striking evidences of the unprogressive state of agriculture in Guam is the absence of many of the important tropical fruits and the scarcity and general inferiority of those in cultivation. With regard to quality probably a single exception, viz, the mango, should be mentioned in modification of the above statement. This

backward and undeveloped condition is not due entirely to lack of enterprise on the part of the people, for other causes, such as the absence of good transportation facilities, past and present, the isolated geographical position of the island, necessitating long voyages between Guam and outside points, have rendered the introduction of live plants, and even of seeds, a matter of difficulty. This same condition also prevents in a measure the importation of fresh fruits and establishes the necessity of dependence upon the island's own resources to supply these products. The people are fond of fruits of almost every kind, and many times the quantity now produced would be consumed if available. An abundance of fruit would not only better the present food supply of the Chamorro and add directly many pleasures to his life, but it would also save him many a dollar which now leaves the island in exchange for expensive canned foods. The problem of increasing and improving the fruit supply of the island entails at least two very general factors, viz, the introduction of the better fruits not in cultivation, together with the improvement, through introduction or development of better varieties of those fruits existing here, and a general improvement in all the various phases of orchard management and fruit production.

There is not a single nursery on the island where trees and plants might be obtained, and probably not one tree or plant that has been grown for the purpose of sale. Graftage in all its forms, and even air layerage so universally practiced in the Orient, are unknown here. Aside from a few such fruits as the banana, pineapple, and breadfruit, which grow from suckers or propagate naturally from the root, the important fruits are all grown from the seed. The cultivation of fruit trees is generally neglected, and this results in lowering the quality and reducing the yield. The following list includes all the fruit, nut, and beverage producing plants on the island, and while apparently rather extensive the list contains but few species of real importance, and only a few that have been introduced into general cultivation.

CATALOGUE OF FRUITS AND TREES BEARING EDIBLE NUTS OR SEEDS USED AS FOOD OR BEVERAGE GROWING ON THE ISLAND OF GUAM.

1. *Aberia caffra*. The Kei-apple.

Recently introduced from Florida by this station. It has not yet fruited on the island.

2. *Aberia gardneri*.

Introduced by this station during the fiscal year 1911, but not yet fruiting.

3. *Achras sapota*. Chico. The sapodilla.

This species is represented in Guam by a few seedling trees which are light bearers of undersized fruit. It has been introduced from tropical America by way of the Philippines, where it is now well established, and is propagated almost entirely by air-layering.

4. *Aleurites triloba*. (*A. moluccana*.) Lumbang. Candle nut.

This species is grown sparingly on the island. It yields well, but the fruits while used as nuts are not utilized for their oil.

5. *Anacardium occidentale*. Kasoy. The cashew.

Introduced but not grown extensively. The fruit is eaten fresh from the tree and the nut is prepared for food by roasting.

6. *Ananas sativus*. Piña. The pineapple.

A single variety producing a small fruit of good flavor is planted at random on many farms, but no systematic cultivation is attempted. The Smooth Cayenne variety was introduced by this station during the fiscal year 1909. This variety has fruited, showing a marked superiority over the native form, and a limited number of plants have been distributed to planters throughout the island. Other introduced varieties growing at the station which have not yet fruited are: Giant Kew, Red Ceylon, Abachi, Porto Rico, Queen, and Red Spanish.

7. *Anona muricata*. Laguana. The soursop.

A common and highly prized fruit. Generally consumed as fresh fruit, but occasionally employed in the preparation of a kind of Spanish dulce or conserve.

8. *A. reticulata*. Anonas. Bullock's heart or custard apple.

Introduced during the Spanish régime. It has escaped from cultivation and now overruns the island. Eaten as fresh fruit by the island inhabitants, but not particularly esteemed.

9. *A. squamosa*. Ates. Sweetsop.

A common and highly esteemed fruit. Grown to considerable extent and utilized in the fresh form.

10. *Antidesma bunius*.

This species has recently been introduced from the Philippine Islands by this station, but is not yet bearing.

11. *Arachis hypogaea*. Kakahuate. Peanut.

The peanut is grown to a limited extent on the island. It yields abundantly and there is always a demand for the nuts. The variety commonly grown is of the small Spanish peanut type. The custom of planting out slips taken from the growing vine is universally followed here.

12. *Areca catechu*. Pugua. The betelnut.

Growing abundantly along ravines and river courses throughout the island without cultivation. Betelnut chewing is a habit indulged in by practically all Chamorros, who acquire the custom in early life. In its preparation for chewing the betelnut is rolled with a small quantity of lime in a leaf of *Piper betel*, known as pupula in the island vernacular. Nuts are sold locally at 1 cent per dozen.

13. *Artocarpus communis*. Dugdug. (Seed-bearing variety.) Lemai. (Seedless variety.) Bread fruit.

The cultivated form of bread fruit is grown extensively on the island and its fruit constitutes a staple food product. It is prepared for food by baking or boiling, or if not wanted for immediate consumption the fresh fruit, after being sliced, is dried in the sun or oven. Prepared in this way it will remain in good condition almost indefinitely. The leaves and young fruits are highly prized as a cattle feed and the fallen fruits are often employed for feeding hogs, and for that purpose are generally boiled.

The seed-bearing variety is also common, especially upon well-drained, rolling or stony soil. The fruit of this variety is not used so generally as food, though the seed called nan̄gka is eaten when boiled. It has been

claimed that the flavor of these seeds when boiled or roasted is not unlike that of chestnuts, though generally the former is much less palatable. Dugdug lumber is largely employed in the construction of buildings, but without the most thorough seasoning it warps and checks badly when exposed to the weather, and for use in exposed places it is not durable and has no special merit.

14. *A. intcgrifolia*. Jak-fruit.

A few trees of this species were introduced and planted a few years ago and some of these have produced fruit. The original seeds were obtained from Manila. Eaten as fresh fruit.

15. *Averrhoa carambola*. Bilimbines. Carambola.

Growing sparingly upon the island; and its five-angled, acid fruits are occasionally used in making jellies and desserts, though it is not greatly esteemed. The fresh fruit has a pleasing flavor and is relished by many Americans; but the Chamorro people care little for it, claiming that it produces hiccough.

16. *Carica papaya*. Papaya. The papaw or melon fruit.

A small, seedy, inferior form of the papaya is widely dispersed over the island. It is seldom if ever planted; but its seeds are scattered by birds which feed upon the fruit. It is sometimes eaten by the natives, but it lacks the flavor of the better cultivated varieties and is not highly prized as an article of food. Since American occupation seeds of the improved forms have been introduced and the fruit from these trees are much more generally utilized.

17. *Carissa arduina*.

This fruit was introduced early in the fiscal year of 1910 by this station and is now bearing a few fruits.

18. *Casimiroa edulis*. White sapota.

A few small seedlings of this species have recently been obtained by this station from southern Florida, and are now growing on the station grounds, but none have yet fruited on the island.

19. *Citrus arautium sinensis*. Cahet. Orange.

The sweet orange is widely distributed on the island, but nowhere extensively grown. One or more trees are generally found near the ranch house or often on the grounds near the town home. Methods of asexual propagation are unknown to the people of Guam, and the trees which often spring from seeds dropped by chance in the dooryard receive no attention. The fruit is generally of inferior quality.

20. *C. decumana*. Lalangha. Shaddock or grapefruit.

Seedling trees of this species are common. There is considerable variation in the quality of fruits produced; but it is generally coarse, thick rinded, and inferior in quality to that of the improved varieties of grapefruit. The fruit is used to a limited extent and only from trees bearing superior fruits.

21. *C. medica acida*. Limon. The lime.

A common fruit in Guam used in flavoring fish, meats, and other dishes and for preserves. The fruit is generally good, thin-rinded, and juicy. If given care and cultivation practiced under modern methods of orchard management the quality of the fruit might be further improved.

22. *C. medica genuina*. Setlas. The citron.

Fruit of generally poor quality is grown to a limited extent. The rind of this fruit is sometimes employed in preserve making.

23. *C. medica limon*. Limon real. The lemon.

Lemons of remarkably good quality considering their seedling nature and the total lack of care given them, are more or less common on the island. The juicy fruits are used in lemonades and in flavoring meats and other dishes.

24. *C. japonica*. The kumquat.

A small importation of nursery trees of the kumquat has recently been received from Japan by this station, but these have not fruited.

25. *C. nobilis*. The Mandarin orange.

A few trees of this species introduced from Japan near the close of the present fiscal year are growing in our orchard, but the trees are small and have not yet fruited.

26. *C. reticulata*. Naranjita. The orange.

A small, sweet orange with thin rind which is easily removed. Fruits spherical to oblate, more or less compressed at the pole, sweet, and of a very pleasant flavor. Rind does not color perfectly, but remains green after ripening, though this is probably due to climatic conditions rather than to any distinctive characteristic of the species. Cultivated to a limited extent, having been introduced a few years ago from the Philippines. It is the most highly prized orange grown in Guam. It is probably a variety of *C. nobilis*.

27. *Cocoloba uvifera*. The sea-grape.

One specimen tree is growing at this station, having been introduced from southern Florida. It is not yet fruiting.

28. *Cocos nucifera*. Niyog. The coconut.

Grown extensively on the island and especially on the low land near the coast and in river valleys. Copra, the dried kernel from which coconut oil is expressed, is the principal article of export. The coconut palm enters into the domestic economy of the Chamorro people in countless ways and in every avenue of their home life, necessities are constantly filled by some portion of the tree or its products. As a food the green nut is employed in various ways in cookery; the sap furnishes sugar, a mild refreshing beverage, or a strongly intoxicating drink. The fermented sap or tody is the common substitute for yeast, and is widely used in bread making. Vinegar and sirup are, by different processes, made from the tody or sap collected from the flower stock, and the coconut oil of commerce is expressed from the dried kernel. The husk which elsewhere furnishes the valuable fiber known as coir is not utilized here. Several varieties are recognized by the native planters.

29. *Coffea arabica*. Kafe. Coffee.

This species is commonly but not extensively cultivated. The island produces coffee of the most excellent quality, and the absence of serious diseases and insect pests favors the development of the industry. At the present time not enough is produced to supply the home demand.

30. *C. liberica*. Kafe Manila. Liberian coffee.

Only a few trees of this species are known on the island. The trees yield well, but the crop being more difficult to gather than from the more shrubby growth of *C. arabica*, the former has not become popular.

31. *Cycas circinalis*. Fadan.

Abundant on Cabras Island and elsewhere in rocky situations. The broken nuts, after soaking in successive changes of water for several days, are ground into a paste and eaten in the form of griddle cakes known as "tortillas." Starch used for laundry purposes is also made from the nut.

32. *Diospyros discolor*. Ebony or persimmon.

Introduced from Manila by this station during the fiscal year 1911. It is growing nicely, but is not yet fruiting.

33. *D. ebenaster*. Persimmon.

Recently introduced from Manila and grown by this station. The species has not yet fruited on the island.

34. *D. kaki*. Japanese persimmon.

A seedling introduced from Manila during the early part of the past fiscal year is making vigorous growth. During the latter part of the same year 100 trees, representing 10 named varieties, were introduced from Japan by this station, and these are growing in various parts of the island. The species has not yet fruited in Guam.

35. *Eugenia jambos*. The rose apple.

Recently introduced from Manila by this station, but it is not yet fruiting on the island.

36. *E. malaccensis*. Makupa. The Otaheite apple.

This species is growing sparingly on the island. The fruit is occasionally eaten.

37. *Ficus carica*. The fig.

Only a few trees are growing on the island. None of the fig trees observed by the writer present a thrifty appearance, and the only fruits so far noted were growing on small, dwarfed trees not more than 3 feet high. These miniature trees were found on the ranch of Capt. Bisset in the district of Upe. Some of the fruits had reached maturity. Much larger trees, however, have been seen, but without fruit.

38. *Fragaria* sp. The strawberry.

A variety of the strawberry has been introduced from Manila, and some fruit has been gathered.

39. *Lansium domesticum*. Lanzones (Philippines).

A delicious fruit obtained from Manila by this station which have not produced fruit as yet.

40. *Lucuma mammosa*. The marmalade plum.

Recently introduced by this station from southern Florida. It has not fruited.

41. *Mammea americana*. The mamee apple.

Introduced from the Hawaiian Islands by this station, but the trees have not yet reached the age of production.

42. *Mangifera indica*. Manñga. The mango.

Cultivated on the island for at least two centuries and is the most highly esteemed fruit of Guam. Trees, of which two races are grown, are comparatively scarce. The Saipan manñga is small, full of fiber, and lacking in flavor. The trees come into bearing earlier and are more constant and heavier bearers than those of the Guam manñga. Trees of the latter race predominate. They produce fruit of medium to large size, almost free from fiber, and of excellent quality. This seems identical with the mango commonly seen on the Manila market. The trees yield light, irregular crops and require from 12 to 20 years to reach a state of production.

43. *Mimusops elengi*.

Recently introduced by this station from the Hawaiian Islands. It has not yet fruited.

44. *Musa paradisiaca*. Chotda. Bananas and plantains.

Bananas and plantains are extensively cultivated for home use, and they constitute a staple food article. Ten varieties are well known, with an additional uncultivated sort known as Chotda, Halom, Tano, or wild

banana. The most common cultivated variety, familiarly known by the natives as Chotda Manila, having been introduced into Guam from the Philippine Islands, is known in the latter place as Letondal or Latardan, and according to Blanco's classification is *M. paradisiaca cinerea*. This variety produces larger yields of fruit than any other grown on the island, but the fruit is of inferior quality and possesses the much more serious fault of bursting the skin before ripening. The generally favorite variety of the plantain type is called Tandugue (*M. paradisiaca magna*) and is known by the Tagalogs by the same name or as Tundoc. It is eaten as fresh fruit or fried as a vegetable. The Chinese Dwarf or Cavendish banana (*M. cavendishii*) has been introduced since the arrival of the Americans on the island, but has not yet become generally distributed.

45. *Myrica rubra*. The Japanese Nagi berry.

Small trees of this species are growing on the grounds of this station, having been recently introduced from Japan.

46. *Nephelium longanum*. The longan.

Recently introduced and growing at this station, but is not producing fruit as yet.

47. *Nypa fruticans*. The Nipa palm.

Growing to a limited extent in brackish swamps and at the mouths of rivers where they empty into the sea and where the waters are made brackish by the entrance of salt water at high tide. The seed, which is edible, is eaten occasionally as a nut.

48. *Pandanus dubius*. Pahong.

Trees of this species are abundant on the island. The seed kernel is edible and the favorite among the Pandans.

49. *P. fragrans*. Kafu.

This screwpine is also common on the island, but the seed, though edible, is small and little used.

50. *P. sp.* Akaoum.

A species of *Pandanus* which does not grow readily from the seed and is for that reason much less common than either *P. dubius* or *P. fragrans*, both of which propagate easily. It is sometimes planted near the ranch house, being propagated from cuttings. The seed kernels are eaten to some extent and are said to rank in favor with the natives between those of *P. dubius*, which is considered most, and *P. fragrans*, said to be least important.

51. *Pangium edule*. Raual.

This species has been introduced, but is little known. It bears an edible fruit and the seed is also eaten after the poisonous principle is removed by steeping in successive changes of water.

52. *Persea gratissima*. Avocado.

Introduced since American occupation and fruited for the first time in 1909. It is a vigorous grower and a prolific bearer in Guam, but the people seem to care little for the fruit. The fruits produced in Guam are equal if not superior to those grown in the Hawaiian Islands.

53. *Pithecolobium dulce*. Camachile.

The camachile is well established, growing without care or planting throughout the island. The pulp about the seeds is eaten fresh from the tree.

54. *Psidium guajava*. Abas. The guava.

The guava has escaped from cultivation and is found growing in waste places in the open lowland all over the island. The fruit is undersized and inferior in quality. It is employed in the preparation of preserves or eaten fresh.

55. *P. guineense*. The Guinea guava.

Recently introduced by this station, but not yet in the producing stage.

56. *Punica granatum*. Granada. Pomegranate.

Grown scatteringly on the island and eaten fresh from the tree. It is not particularly esteemed here, the variety being a very inferior one.

57. *Sandoricum indicum*. Santol.

The species is represented in Guam by a few trees that were introduced from Manila a few years ago. It has fruited but has not become distributed or well known to the people.

58. *Sterculia acuminata* (*Cola acuminata*). Kola-nut.

Introduced from Ceylon by this station during the fiscal year 1911, but not yet fruiting.

59. *Tamarindus indica*. Kamalindo. The tamarind.

The tamarind has been introduced and is grown to a limited extent for its acid fruit.

60. *Terminalia catappa*. Talisai. Indian almond.

This large tree is common and is husbanded by the inhabitants for the seed, the kernel of which is generally eaten in the fresh form.

61. *Theobroma cacao*. Kakao. The chocolate tree.

Cacao was cultivated much more extensively during former years than it is at present. The plantations suffered much damage from the typhoons which visited the island in 1900, and the industry has never fully recovered. Chocolate of a very superior quality is made from the bean, but not in sufficient quantities to supply the local demand.

62. *Triphasia trifoliata*. Lemon de chino. Bergamot lime.

Very common throughout the island, growing in uncultivated thickets. The fruit is sometimes eaten fresh or employed in the preparation of a conserve.

63. *Vitis rotundifolia*. Ubas. Muscadine grape.

Three varieties of the muscadine grape have been introduced by this station and are growing nicely. They have not yet produced fruit.

64. *Ximenia americana*. Piod.

An edible fruit grown to some extent in Guam.

65. *Zizphus jujuba*. Manzanitas. The jujube.

An edible but unimportant fruit.

ACKNOWLEDGMENT.

In concluding this report it is proper that mention be made of the many courtesies and aid extended the station by the present governor, Capt. G. R. Salisbury, United States Navy, and of the efforts being made by the island's chief executive to bring about increased production and to better the condition of the people by encouraging the development of agriculture, the only resource of the island.

ENTOMOLOGICAL NOTES.¹

By DAVID T. FULLAWAY.

While the work required of the entomologist was almost entirely of a technical nature, it is necessary to preface the detailed account of the entomological data gathered with a brief statement of island conditions, in order to bring the bearing of the work in proper aspect.

Agriculture, though generally practiced by the natives, is very poorly developed. The system is the one commonly in vogue in the former Spanish dependencies, namely, the development of ranches or farms more or less removed from the villages. In most cases these are independently owned, though tenantry is not altogether uncommon. Sometimes the native lives on his ranch, but for the most part he lives in the village and goes out to his ranch for short periods. At the present time many of the ranches have been abandoned and the owners are working by the day for the Navy Department on various public improvements. A practice which is becoming quite common is the leasing of ranches planted in coconuts to Japanese traders, who have the crop for a stipulated price in addition to responsibility for the upkeep. The effect of this tendency toward abandonment of the farm on economic conditions in the island is very detrimental to the general welfare.

The methods of farming are crude, but there has recently been a rather steady improvement in this regard. The most important crops are coconuts, corn, coffee, rice, tobacco, and sugar cane. Copra from the coconut is the only product exported, and last year's crop amounted to \$40,000. Extensive plantings of corn are made each year, but the losses are usually great, and all that is har-

¹ The writer desires to acknowledge with thanks the assistance of the entomologists of the Bureau of Entomology, United States Department of Agriculture, the Hawaiian Sugar Planters' Experiment Station, and the Bureau of Science in Manila in the recognition of the pests mentioned herein.

Mr. E. A. Schwarz, of the Bureau of Entomology, is responsible for the determinations of *Carpophilus maculatus*, *Epuræa luteola*, *Harmonia arcuata*, *Coccinella repanda*, *Daulis mulsanti*, and *Chlœnius biguttatus*; Mr. C. L. Marlatt, of the Bureau of Entomology, for *Lepidosaphes* sp. near *lasianthi*, *Pulvinaria psidii*, *Pseudococcus* sp., *Aonidiella aurantii*, *Pseudococcus citri*, and *Saissetia nigra*; Mr. J. G. Sanders, formerly of the Bureau of Entomology, for *Pseudococcus cocotis*; Mr. C. S. Banks and Mr. W. Schultze, of the Bureau of Science, Manila, for *Margaropus annulatus australis*, and *Marasmia trapezalis* and *Pyrausta vastatrix*, respectively; and Mr. F. Muir, of the Hawaiian Sugar Planters' Experiment Station, for *Rhabdocnemis fausti* and *Perkinsiella* n. sp. near *sinensis*. The writer assumes responsibility for the other names.

vested is consumed on the island. Coffee was formerly more extensively grown than at present and formed an article of export. Sugar cane, rice, and tobacco are not extensively grown, and the products are used entirely in Guam. Forage crops are assuming more importance in view of the large number of horses, mules, and other stock used and maintained by the Government and the growing cattle industry. Some of the island fruits are of excellent quality and bring good prices in the market, but none are exported. They include the mango, citrus fruits, breadfruit, bananas, avocado, soursop, and pineapple. Recent introductions are strawberries, peaches, water-melons, smooth Cayenne pineapple, avocados, and improved papayas. Vegetables of good quality are cultivated, including the sweet potato, eggplant, beet, cucumber, radish, and cabbage. Other plants of economic importance are cotton, rubber, broom corn, cassava, peanut, kapok, bamboo, and numerous hedge trees, such as the camachile (*Pithecolobium dulce*), ironwood (*Casuarina equisetifolia*), *Cassia grandiflora*, *C. fistula*, etc.

A list of the principal economic plants with their insect depredators follows:

SPECIAL FIELD CROPS.

Coconut palm. The coconut palm is peculiarly free of insect pests and fungus diseases, and the groves are all, as far as observed, in thriving condition. Seedling plants are occasionally attacked and destroyed by a borer, the widely distributed *Rhabdocnemis obscurus* (a variety close to the one from Christmas Island, described as *R. fausti*, but merely a variant of the above-named species). A mealy bug, *Pseudococcus cocotis*, is quite common on the trunk beneath the leaf sheaths and does considerable damage. It is very much reduced by a coccinellid beetle, *Scymnus* sp. Slightly higher up on the trunk and leaves a flat scale, *Lepidosaphes* sp., is commonly found. Hymenopterous parasites were bred from this scale and to some extent check its multiplication. A phasmid or walking stick feeds on the leaf, but does no appreciable damage, although the leaves are often badly shattered, presumably from whipping and other mechanical injuries. In such condition they harbor certain caterpillars which are usually found in situations presenting dry dead vegetable matter. The larva of a tineid moth is also commonly found on the leaves. The pupa is parasitized by *Chalcis* sp. No artificial remedies for these insects are recommended.

Corn. There are a large number of insects attacking corn. Seed which was rotting was found to harbor earwigs, wireworms, and other ground forms. Small plants are badly eaten by the caterpillar of a pyralid moth, *Marasmia trapezalis*. The caterpillar, which is green with broad and flat black tubercles, folds the leaves

in their outer portions and in the protection thus afforded eats through the leaf to the lower epidermis. Plants in all stages of growth are attacked by leafhoppers (*Peregrinus maidis*) and plant lice (*Aphis maidis*). When the stems are formed the plants are attacked by a moth borer, a sordid white caterpillar with conspicuous, small tubercles. This is the larva of a pyralid moth recently described from the Philippines by Schultze as *Pyrausta vastatrix*. The borer is also commonly found in the ears. In both stems and ears it pupates within its burrows, which are readily noticed by the accumulations of frass at the entrances. The ears are also badly eaten by the noctuid larvæ *Heliothis obsoleta* var. *Melanitis leda* was also bred from the caterpillar, which was collected on a corn leaf. Damaged ears harbor the usual insects attracted by fermentation and dry dead vegetable matter. Nitidulid beetles (*Carpophilus maculatus* and *Epuræa luteola*), a small cockroach (probably *Phyllodromia* sp.), the coffee bean weevil, *Aræcerus fasciculatus*, and a small tineid, were quite commonly found in such situations. A large locustid is also found on the foliage and is probably predaceous on plant lice and hoppers, although it also occasionally nibbles at the foliage. The aphidids or plant-lice and hoppers are commonly attended by red ants and are preyed upon by several coccinellid beetles (*Harmonia arcuata*, *Coccinella repanda*, and *Daulis mulsanti*) as well as by the larva of a syrphid fly (probably *Xanthogramma grandicornis*) and of a hemerobiid. Probably the most serious corn pest is the grain weevil, *Calandra oryza*, which attacks the dried stored seed and often does considerable damage to the crop. Rodents are nearly as injurious (to the standing crop) as the weevil. In many fields at least a third of the ears were eaten wholly or in part. Nothing is recommended in the way of artificial control, as the benefit derived from the use of insecticides on growing corn would scarcely repay the expense involved. The protection of the fields from rodents is very necessary. The seed weevil is very easily controlled by sun and heat drying, careful storage, and fumigation. The plant louse and leafhopper are both parasitized in the Hawaiian Islands, but no parasites were reared from them in Guam.

Coffee. The coffee plant seems to be particularly free of insect pests. A few common coccids, *Pulvinaria psidii*, *Saissetia hemispherica*, a Diaspine species, and *Pseudococcus* sp. were the only pests taken on it. Occasional spraying with kerosene emulsion or scalecide is recommended.

Rice. All that was seen of this crop was stubble and some volunteer stems. Planting was just beginning in September. Mr. Thompson, however, states that there are no serious pests. A mealy bug, *Pseudococcus* sp., is commonly present between the stem and leaf sheath. Cutworms and the rice weevil are likely to do some

damage to the crop as well as a locustid, which was commonly observed feeding on grass stems.

Sugar cane. The canes were very inferior and the methods of cultivation rather crude. At the time of harvest the canes were all badly damaged by rats. The only insect pests observed were the cane borer (*Rhabdocnemis obscurus* var.), a leafhopper (*Perkinsiella* n. sp. near *sinensis*), and a mealy bug (*Pseudococcus sacchari*). No parasites were observed, although the first two are very much parasitized in the Australasian region. The crop is poor and there is much waste in extracting the juice. Artificial remedies for the insect pests could not be considered, but if the value of the crop would warrant it, much larger yields could be obtained by protecting the canes from rodents and by introducing parasites of hopper and borer.

Tobacco. The tobacco seemed to be of very poor quality. It is made into cheroots or "chupas" by the natives, but the "chupas" made from Saipan leaf are much preferred to the native product. The principal pests are *Heliothis obsoleta*, which feeds on the leaves and buds and consumes the contents of the seed pods, and a tortricid stem borer. A capsid bug also blights the leaves. A locustid is commonly found on tobacco, but whether it oviposits in the stems or frequents the plant in search of food is not known. Some of these forms live partly on insect and partly on plant food.

FORAGE AND COVER CROPS.

Kafir corn. Kafir corn is badly infested in all stages of growth by the plant-louse, *Aphis maidis*. The heads are also badly damaged by the caterpillars of two common moths found frequently in maturing grains (probably *Cryptoblabes* sp. and *Batrachedra* sp.). The *Cryptoblabes* is parasitized in the pupal stage by *Chalcis* sp.

Broom corn. Broom corn is also attacked by plant lice (*Aphis maidis*) and by a hopper (probably *Peregrinus maidis*). A caterpillar feeds on the leaves, but the moth was not secured in breeding.

Para grass. The caterpillar of a pyralid moth commonly rolls the leaves. It is parasitized by an *Apanteles*. A psyllid is also found on the leaves and a locustid occasionally gnaws the stems, but does little apparent damage.

Bermuda grass. The larva of a pyraustid moth (2015) is the principal depredator on Bermuda grass, which is now used largely for lawns. This caterpillar is a leaf roller when small, but when full grown works at the base of the stems and mats the grass considerably. When appearing in excessive numbers, as it does at frequent intervals, it gives the lawns a very shabby appearance. *Spodoptera mauritia* was also bred on *Cynodon*, and a grass coccid, probably *Antonina bouteliae*, is found on the lower stems and roots.

Cowpea. Cowpeas are attacked by the melon aphis, *Aphis gossypii*, which are heavily parasitized. A lepidopterous larva commonly mines and splits the leaves. It is about $\frac{3}{8}$ inch long, wholly red, with distinct segmentation. The moth is a small tineid.

Pigeon pea. Pigeon peas were badly infested with an armored scale, but the scale is very much parasitized by *Tomocera*.

Peanut. An armored scale and a mealy-bug, *Pseudococcus virgatus*, are commonly found on the peanut. The stored nuts are damaged by the caterpillar of a phycitid moth (probably *Ephestia*).

Cassia. The pods are badly eaten by a tortrix, *Cryptophlebia illepidia*.

Crotalaria. The pods are eaten by the slug-like caterpillar of *Lycæna bætica*. The plant is also attacked by a stem borer, but the adult was not secured in breeding.

FRUITS.

Mango. There are two varieties of mango in Guam; the more frequent one has a very superior fruit. The trees are singularly free from insect pests. A small geometrid was reared from a caterpillar taken on mango foliage; a mealy bug, *Pseudococcus* sp., was taken on the roots; and the larva of a phycitid moth working between fruits was bred; but no serious pests were found on this handsome and valuable tree.

Citrus. Citrus trees are badly infested with a mealy bug, *Pseudococcus citri*, and *Aonidiella aurantii*. The fluted scale is also bad at times and occasionally plant lice resembling *Myzus citricidus* are found on the trees.

Breadfruit. The breadfruit is not very much attacked by insects. An infestation of plant lice, believed to be *Aphis gossypii*, was once observed.

Banana. The banana also is rather free of insect pests. Plant lice resembling *Pentalonia nigronervosa* are found beneath the sheaths on the lower stem.

Avocado. No pests were found on the avocado, which has been introduced from Hawaii within recent years.

Soursop. Two mealy bugs were commonly found on the soursop, *Pseudococcus virgatus* and an undetermined species of the same genus.

Pineapple. A mealy bug, *Pseudococcus bromeliæ*, is very injurious to pineapples, occurring in clusters at the base of the fruit, blighting it to some extent and producing rot.

Strawberries. No pests were noticed on strawberries.

Peaches. None were noticed on peaches.

Watermelons. Plant lice, probably *Aphis gossypii*, commonly infest watermelon plants. This species is heavily parasitized.

Papayas. No pests were noticed on papayas.

Roselle. The larva of a tortricine moth does considerable damage to this plant.

VEGETABLES.

Sweet potato (Pl. V, fig. 1). Sweet potato plants are badly blighted by a fungus disease. Two common sweet potato weevils, *Cylas formicarius*, and *Euscepes* (*Cryptorhynchus*) *batatae* are abundant and do considerable damage to the crop. A *Pulvinaria* on the leaves resembles *P. tyleri* in the Philippines.

Eggplant. The foliage is badly infested with plant lice, probably *Aphis gossypii* and mealy bugs, *Pseudococcus virgatus*.

Beet. Beet plants are subject to the frequent attacks of a defoliator, the beet webworm, *Hymenia fascialis*. An *Apanteles* commonly parasitizes the larva and a carabid beetle (*Chlaenius biguttatus*) preys upon it to some extent. Plant lice, *Aphis* sp., commonly infest the foliage. Spraying with arsenate of lead at frequent intervals would do much to reduce the webworm injuries.

Cucumber. The foliage is commonly infested with plant lice that resemble *Aphis gossypii*.

Radish. The plants are commonly attacked by plant lice thought to be *Aphis gossypii* and the imported cabbage worm, *Hellula undalis*. The roots are often very badly damaged. Repeated sprayings at intervals of 15 days with arsenate of lead is recommended.

Cabbage. Cabbages fail to head in Guam, and for that reason are little grown. They are commonly attacked by the caterpillar of a pyralid moth.

Horseradish. Horseradish is attacked by the same pyralid and by the imported webworm, *Hellula undalis*.

OTHER ECONOMIC PLANTS.

Cacao. There are a few old cacao plantations on the island which have practically been abandoned since a typhoon of some years ago. An examination was made of one of these plantations. The general condition of the trees showed neglect. Some were putting out a small new growth, but practically all appeared to be in slow decay from the roots up. The bark was loose and riddled; beneath it the work of ants, termites, and scolytid beetles could be noticed. A damaged specimen of a longicorn was rescued with proctotrypid cocoons adhering. These bred a new genus near *Laelius*, but the grub was beyond identification. The foliage showed fungus attack. A caterpillar common on dead wood was also found, but the moth was not bred. Captain Duarte, an old resident, vouchsafes the information that a large borer seasonally attacks cacao; it is a lepi-

dopterous larva, bores in the stems, and produces serious injury to the plants.

Cotton. Cotton is not extensively grown. Nevertheless some attention was given to the insects. The plants are often badly infested with mealy bugs *Pseudococcus virgatus*, plant lice, *Aphis gossypii*, and *Aphis* sp., and armored scale, *Saissetia nigra*. *Aphis gossypii* is heavily parasitized by a minute chalcid, *Aphelinus* sp., and is also kept in check by the common ladybird beetles and predaceous larvæ of a syrphid fly *Xanthogramma grandicornis*. The most injurious pest is a stem borer, probably *Earias fabias*, which weakens the branches and causes frequent breaking.

Ceara rubber. A mealy bug, *Pseudococcus virgatus*, and a soft scale, *Saissetia nigra*, are found on Ceara rubber trees.

Cassava. No pests were observed on cassava.

Kapok. An armored scale, *Saissetia nigra*, is found on the leaves of the kapok. It is parasitized by *Tomocera* sp.

Bamboo. *Asterolecanium bambusæ* is very common on bamboo stems. It also is parasitized.

HEDGE, SHADE, AND ORNAMENTAL TREES.

Camachile *Pithecolobium dulce* (Pl. V, fig. 3). This leguminous plant is being used for hedges. The foliage is destroyed by a leaf folder, the larva of a microlepidopterous insect. An armored scale is found on the bark.

Ironwood (*Casuarina* sp.). This tree is often badly infested with fluted scale, *Icerya purchasi*, although *Scymnus* sp. is very active in reducing the infestation.

Cassie. The stems are bored by the larva of the tortricids, *Cryptophlebia illepidata*, and of a tineid.

PESTS OF DOMESTIC ANIMALS.

Fortunately none of the serious animal diseases so common in the Philippines and other tropical regions are prevalent among the Guam herds and domestic animals. The Australian cattle tick, *Margaropus annulatus australis*, and the common carabao louse, *Hematopinus tuberculatus*, however, are commonly found on carabao and oxen. As the tick is also said to be an intermediate host for the *Piroplasma* of Texas fever, its presence in Guam is more or less of a menace, especially in view of the introduction of animals from other regions. Both, moreover, are great annoyances to the cattle and when numerous affect the condition of the animals. Some relief may be secured by spraying with Zenoleum. Chickens also aid in the reduction. An ant, said to be the common fire ant (*Solenopsis geminata* subsp. *rufa*) is a great menace to cattle and sheep



FIG. 1.—HONOLULU RED SWEET POTATOES.



FIG. 2.—NEWLY PLANTED CITRUS ORCHARD.

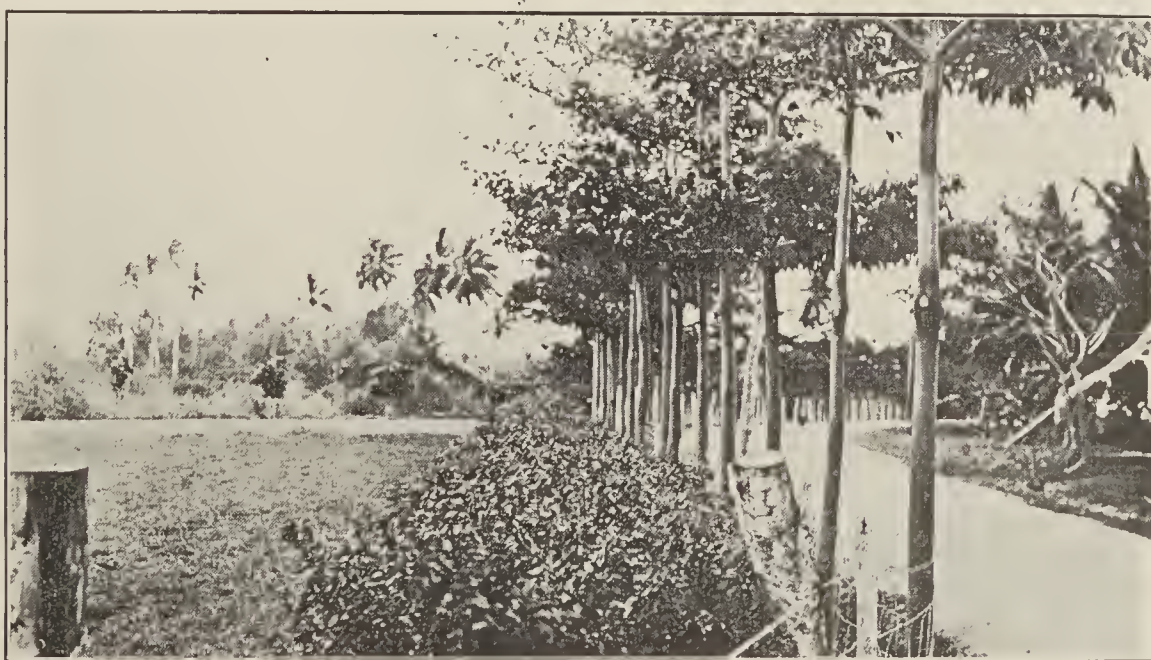


FIG. 3.—CAMACHILE HEDGE AND KAPOK LIVE FENCE POSTS.

raising, as it attacks newly born and defenceless animals in the mucosæ, producing lesions which often lead to serious maiming or death. Wounds on the backs of hogs frequently become blown by a large bluebottle, *Calliphora* sp.

HOUSEHOLD INSECTS.

A large number of common insects are included under this heading—insects which have in a way become domesticated and by the movements of men from one place to another or by commercial operations have become almost cosmopolitan. Most of these are annoying pests and are much more prevalent and annoying in Guam than elsewhere.

The common house fly, *Musca domestica*, and another muscid breed in animal droppings with very little check and become excessively annoying insects, not only in dwellings but throughout the island along the traveled roads. There are two species of mosquitoes, a culicine (*Culex* sp. near *vishnui*) and *Stegomyia scutellaris*. The latter is very abundant in the forests and makes progress through the brush very unpleasant. It is impossible to remain in the country overnight with any degree of comfort.

The Blattidæ are represented by eight species. The common house-infesting cockroaches, however, are *Periplaneta americana*, *Steleopyga decorata*, and *Polyzosteria soror*. *P. americana*, usually referred to as the "Guam eagle," is very annoying in houses at night. Its egg capsules are parasitized by *Evania appendigaster*, which is in turn parasitized by *Tetrastichus hagenowi*. Book lice, *Troctes divinatoria*, and silver fish, probably *Lepisma saccharina*, as well as cockroaches, get into library shelves and do considerable damage to books. The Formicidæ are represented by about 15 or 16 species. Several of these are common about houses, especially the fire ant, which is granivorous. The camponotine ants of the forests are parasitized by a *Pseudochalcura*, and there is also a common myrmelleonid, the larva of which preys upon ants. It is common both in the woods and around habitations. A termite does considerable damage to woodwork, books, records, etc. The bedbug, *Cimex lectularius*, is common in houses, and the bodies of the natives are often infested with lice, both *Phthirius inguinalis* and *P. capitata*.

BENEFICIAL INSECTS.

The island is fairly well provided with predaceous and parasitic forms, which check the excessive multiplication of injurious species. There are three common coccinellids (*Harmonia arcuata*, *Coccinella repanda*, and *Daulis mulsanti*) preying on plant lice and leafhoppers, and another, a *Scymnus*, inimical to mealy bugs. The larva of a

syrphid fly, *Xanthogramma grandicornis*, and of a hemerobiid feed on plant lice. *Xanthogramma*, however, is parasitized and so its utility is greatly reduced. There is also a common chrysopid the larva of which preys on plant lice and other small-bodied insects. A forficulid, *Chelisoches morio*, has similar habits. A carabid, *Chlœnius biguttatus*, is very active about vegetable patches as a caterpillar predator. A eumenid wasp, *Rhynchium* sp., gathers caterpillars as food for its young and in this way must be considered a very beneficial insect. Three common vespids, one a *Polistes*, also destroy many caterpillars, and there are one or two tachinid flies parasitic on caterpillars, but specimens were not secured in breeding. There are numerous species of dragonflies, which hawk the air in search of small-bodied flies and play a very efficient rôle in the reduction of mosquitoes. The honey bee, introduced some years ago from Hawaii, is a very common insect in Guam. Many hives are maintained, but they as a rule are poorly cared for. Species of *Gonatopus*, leafhopper parasites, *Parasierola*, and *Trichogramma* were also secured without learning the host relation.

Some very common insects in Guam not mentioned above are the milkweed butterfly, *Anosia plexippus*; the mole cricket, *Gryllotalpa africana*, which often becomes a pest, since it feeds on the roots of various plants; and the vinegar fly, *Drosophila ampelophila*.

In comparison with some other tropical regions where the insects have been studied, the island can be said in a general way to have few injurious insects, although its undeveloped state leaves one rather in doubt. This statement, however, is made merely to emphasize the importance of a strict quarantine of plant introductions. A large number of the present injurious insects are insects which have been introduced on plants or plant commodities and many more will inevitably come if plant introduction is not discouraged or whatever is brought in is not thoroughly examined, cleaned, and fumigated. While the writer was in Guam, Japanese beetles (*Adoretus tenuimaculatus*) and other pests in a consignment of plants from Japan were intercepted in quarantine. This matter has been brought to the attention of the Government and a regulation issued covering it. The continuation of the present happy condition of a meager fauna depends largely on the thoroughness with which this regulation is enforced.

The introduction of insect predators and parasites of local injurious insects is an important line of work. While the writer was on the island an attempt was made to introduce a coccinellid beetle, *Cryptolæmus montrouzieri*, a very efficient mealy-bug feeder in Hawaii. Out of a lot of several hundred sent, about 40 or 50 were liberated near the office building and a new generation had appeared before the writer left. Hymenopterous parasites of dungflies from Hawaii,

Spalangia and Eucoila, are also being introduced. One lot was liberated in September, but the result of its introduction is not known. It is also proposed to send *Novius cardinalis* to Guam to control the fluted scale, although *Scymnus* sp. now keeps it fairly well checked. Other introductions may follow later. Improved hives for the honey bee have been secured by the station from Hawaii and demonstrations of their superiority to the ordinary box hive will be made.



